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A multi-component universal intervention to improve diet and physical activity among adults with intellectual disabilities in community residences: A cluster randomised controlled trial

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ABSTRACT

People with ID have an increased risk for unhealthy diets, physical inactivity and weight disturbances. The aim of the current study was to investigate the effectiveness of a novel and complex intervention to improve diet and physical activity, targeting both caregivers and residents, in community residences for people with ID. A three component intervention based on Social Cognitive Theory was developed, including: (1) appointment of a health ambassador in each community residence attending network meetings, (2) a study circle for caregivers, and (3) a health course for the residents. The intervention lasted for 12–16 months and allowed for some local tailoring. A cluster randomised controlled trial, randomised at residence level, was conducted to evaluate the effects of the intervention. Thirty community residences for people with mild or moderate ID in Stockholm County, Sweden, were included. A total of 130 participants, 74 women and 56 men aged 20–66 years, entered, and 129 participants completed the study. The primary outcome was physical activity, measured by pedometry. Secondary outcomes were BMI, waist circumference, dietary quality measured by digital photography, satisfaction with life assessed with a scale, and work routines assessed with a questionnaire. Outcomes were related to intervention fidelity. A positive intervention effect was found on physical activity, with an average increase of 1608 steps/day among participants in the intervention group ($P = 0.045$). The effect size was 0.29 (Cohen's d). The type of residence was found to be an effect moderator. A positive intervention effect was found as well on work routines, with an average increase of 7.1 percentage points on a self-assessment scale among residences in the intervention group ($P = 0.016$). No significant effects were found on BMI, waist circumference, dietary quality, or satisfaction with life. In conclusion, this innovative intervention was effective in improving physical activity and work routines. It is likely that even greater effects could be achieved by improvements in implementation strategies, leading to higher fidelity.

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1. Introduction

People with disabilities carry a higher disease burden than the population in general (Arnhof, 2008; World Health Organization, 2011). Among people with intellectual disabilities (ID), unhealthy diets (Adolfsson, Sydner, Fjellstrom, Lewin, & Andersson, 2008; Draheim, Stanish, Williams, & McCubbin, 2007; Robertson et al., 2000), physical inactivity (Emerson, 2005; Robertson et al., 2000), and weight disturbances (Bhaumik, Watson, Thorp, Tyrer, & McGrother, 2008; Emerson, 2005; Hove, 2004; Moran et al., 2005; Robertson et al., 2000) are more common than in the general population, causing ill health and increasing the risk of chronic diseases. According to a Swedish study cardio-metabolic risk factors are common among people with ID already when they are adolescents (Wallen et al., 2009).

It may be assumed that people with ID in general have a low health literacy, which is associated with poorer health outcomes (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011). Research findings from health education interventions in the target group have shown promising results (Bazzano et al., 2009; Ewing, McDermott, Thomas-Koger, Whitner, & Pierce, 2004; Heller, Hsieh, & Rimmer, 2004a; Marshall, McConkey, & Moore, 2003; Melville et al., 2011). However, the number and type of intervention components varies between different studies and, in addition, there is a lack of controlled trials, making comparisons difficult (Jinks, Cotton, & Rylance, 2011).

According to a review of health promotion studies in the target group, there is some evidence of fitness and psychosocial benefits of community-based physical activity programmes (Heller, McCubbin, Drum, & Peterson, 2011). The evidence for weight reduction is stronger in multi-component interventions, including a nutrition component (Heller et al., 2011). In a review of weight loss interventions, the evidence supports interventions that take account of the context of the individuals as well as carer involvement (Hamilton, Hankey, Miller, Boyle, & Melville, 2007).

In Sweden many adults with ID live in community residences, where they are entitled to daily support. Because adults with ID often make decisions in collaboration with caregivers, it is of great importance that caregivers are motivated to promote the health of residents (Hamilton et al., 2007). The support and attitudes of caregivers have been shown to play a key role for participation in physical activity, for example (Heller, Hsieh, & Rimmer, 2004b; Hutzler & Korsensky, 2010; Mahy, Shields, Taylor, & Dodd, 2010; Stanish & Frey, 2008). Regular contact between caregivers and residents is an opportunity to support healthy behaviours in an everyday context, where both caregivers and residents can be actively involved (Marshall et al., 2003). For this reason it is important to make sure that the caregivers possess the knowledge, skills, and resources needed (Hanna, Taggart, & Cousins, 2011; Melville et al., 2009; Stanish & Frey, 2008), including possibilities for them to reflect on the ethical dilemma of supporting healthy behaviours without encroaching on individual autonomy (Bergstrom & Wihlman, 2011). The caregivers are not able to influence all aspects of the physical environment, but they certainly can influence several, such as meals and opportunities for physical activity (Marshall et al., 2003; Stanish & Frey, 2008).

According to research in both Sweden and the United States on deinstitutionalisation and integration in society, changes in the physical and social environment have brought about unintentional body weight changes and nutrition-related problems (Bryan, Allan, & Russell, 2000; Gabre, Martinsson, & Gahnberg, 2002), indicating that support is important to promote health behaviour in this group.

Taken together there is a call for health promotion interventions that address staff training, knowledge and motivation of the target group, and organisational factors within community-based organisations (Heller et al., 2011). We therefore developed a multi-component intervention based on Social Cognitive Theory (SCT), according to which behaviour, personal factors, and environmental influences all interact in a dynamic process (Bandura, 1986). People adopt behaviours by observing others, the environment influences the behaviour and the cognitions of an individual might influence the environment. This type of intervention is complex, meaning that individual components interact leading to synergetic effects (Hawe, Shiell, & Riley, 2004).

The current study aims to investigate if a novel three-component programme targeting both the residents and the caregivers could improve physical activity and dietary habits among people with ID living in community residences. Our hypothesis was that by at the same time improving health literacy among the residents, the caregiver's capacity and work routines as well as aspects in the physical and social environment, it might be possible to improve health related behaviours. The specific research questions of the study were (1) what are the effects of the intervention on residence level outcomes (work routines)? (2) What are the effects of the intervention on individual level outcomes (physical activity, dietary quality, BMI, waist circumference and satisfaction with life)? (3) Are the effects related to intervention fidelity?

2. Methods

The design of this study is a cluster randomised controlled trial, the study protocol of which has been published (Elinder, Bergstrom, Hagberg, Wihlman, & Hagstromer, 2010). Since the intervention targeted the individuals and the caregivers collectively in each residence, the unit of randomisation was the residence. Reporting is carried out according to CONSORT guidelines for cluster randomised trials (Campbell, Piaggio, Elbourne, & Altman, 2012).

2.1. Recruitment of participants

An invitation letter was sent to administrative key persons in each of the 25 municipalities in Stockholm County and 14 city districts in Stockholm city, who were asked to forward the invitation to community residences for adults with ID, about 500 residences in total.

The invited residences comprised group homes as well as homes with supported living. In both types of housing, each resident has his or her own flat, with kitchen and bathroom, and there are common rooms as well. All residents have the possibility to prepare their own meals, but most residences also offer opportunities for having dinner together, either every evening or a few evenings per week. People in both types of residences receive support from staff in their everyday lives, but people in group homes often are in need of more support than people in supported living, who usually live more independent lives. The number of residents in a group home is about five, while it might be higher in homes with supported living (The National Board of Health and Welfare, 2007). Community residences were eligible for inclusion if they were intended for residents with mild or moderate ID and if at least three of the residents chose to participate in the study. The level of ID was not individually examined, but all participants had the ability to understand basic information about the intervention and to decide upon participation. Participants gave informed written consent and their trustees received written information (Elinder et al., 2010).

Recruitment took place between May 2009 and February 2010. A total number of 60 community residences expressed an initial interest in participation and were assessed for eligibility (Fig. 1). Six did not meet the inclusion criteria, and 21 refused to participate after receiving more information about the project, leaving 33 residences for baseline measurements.

A simple randomised design was used, and a researcher with no knowledge about the participants conducted the randomisation. Thirty-three sealed envelopes containing an identification number for each residence were mixed in a basket, and the first 17 envelopes were assigned to be the intervention group. The remaining 16 envelopes were assigned to the control group. In total, 139 individuals were included. Before the intervention started, three residences with a total of

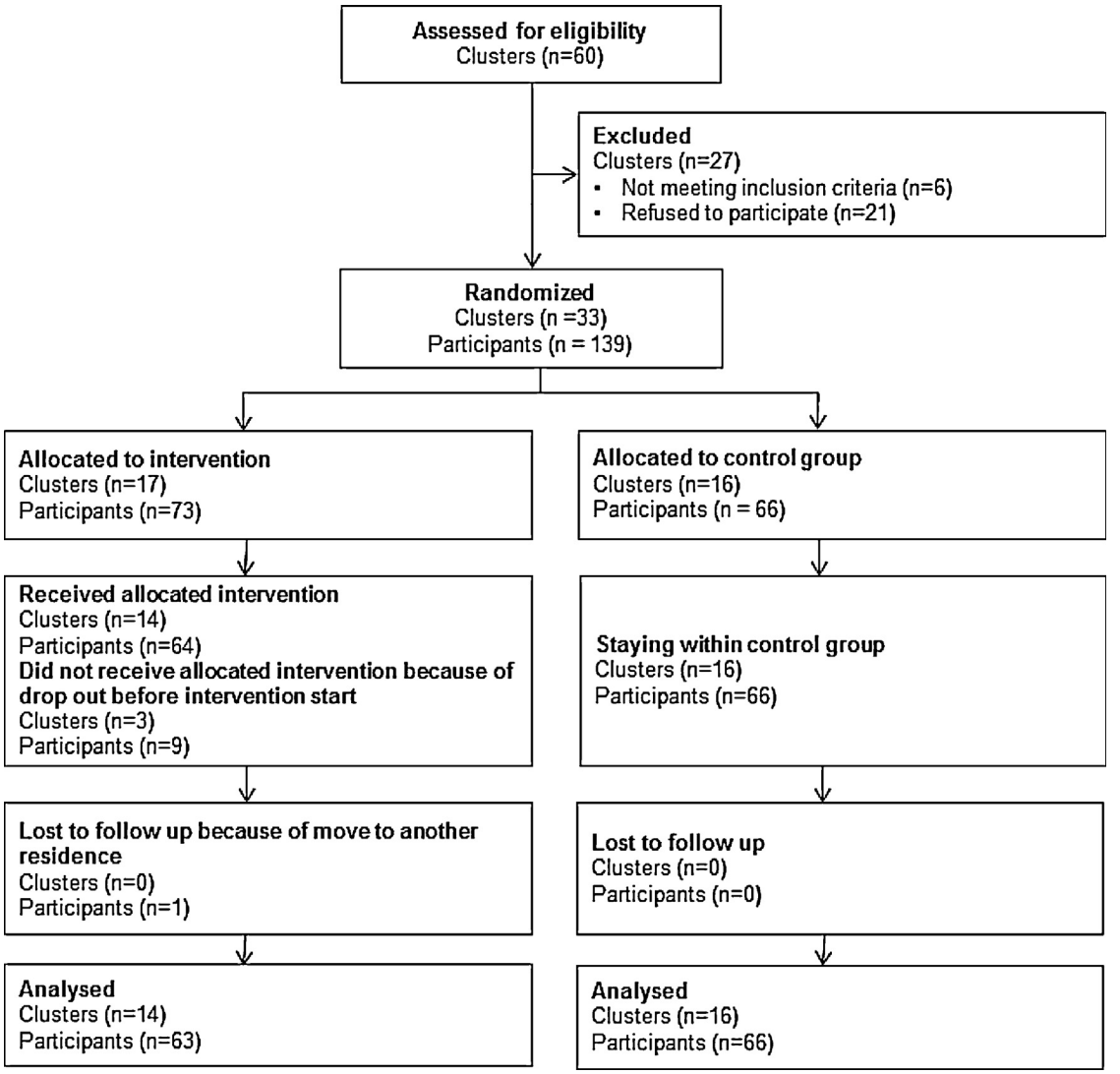

Fig. 1. Flow of clusters and participants throughout the trial.

nine participants, randomised to intervention, dropped out. According to managers and caregivers, the reasons for dropout were reorganisations or other reasons not directly connected to the intervention.

2.2. The intervention

The intervention was a complex intervention, simultaneous targeting both residents and caregivers. The intervention was based on SCT (Bandura, 1986), and in line with this theory it aimed to improve health behaviour of the residents through personal factors, such as knowledge, skills, preferences, and self-efficacy among the residents as well as through improvements in their social and physical environment, which is very much dependent on the knowledge, skills, and work routines of the caregivers. The intervention included three components, which were developed in cooperation with managers, caregivers, and The Swedish National Association for Persons with Intellectual Disability, to achieve appropriateness for a real-life setting. The components comprised (1) the appointment of a health ambassador in each community residence who also attended network meetings with the other health ambassadors; (2) a study circle for caregivers based on the principles of peer education; and (3) a health course for the residents (Elinder et al., 2010).

Implementation strategies, referring to specified activities designed to put into practice an activity or programme of known dimensions (Fixsen, Naoom, Blase, Friedman, & Wallace, 2005), included an introductory meeting for managers and caregivers, a one-day education for course leaders of the health course for the residents, newsletters to the participating residences, and coaching on demand. Each residence had the possibility to schedule the intervention to fit their routines, but was asked to complete the entire programme within 12–16 months. The residences did not start simultaneously, so the entire intervention was carried out during the period from March 2010 to December 2011. Community residences in the control group continued to work as usual, but were promised the possibility of taking part in the intervention after completion of the study (wait-list control).

2.2.1. Health ambassadors

One health ambassador was appointed in each residence, chosen by the manager and caregivers themselves. The task of the health ambassador was to provide health information to colleagues and to organise health-promoting activities for the residents. The ambassadors were invited to six network meetings, 3 h each, to improve knowledge on health behaviours and to learn from one another. Each network meeting included lectures or workshop activities and discussions based on the needs and interests expressed by the group. The ambassadors received coaching in terms of regular newsletters, information materials sent out by e-mail or mail if they missed network meetings, and follow-up phone calls. They also received coaching on demand by phone or e-mail.

2.2.2. Study circle for caregivers

All caregivers in each community residence were encouraged to participate in the study circle named ‘Focus Health’, which included ten sessions, approximately 90 min each, to discuss and plan their health-promotion work in the residence. Focus Health was based on written material developed for this project, which also served as a manual for this component. A discussion leader was appointed from the staff in each residence to lead each session. The aim of the study circle for caregivers was to increase their knowledge and skills regarding health and health determinants and to empower them to improve work routines as well as to make improvements in the social and physical environment. Each chapter included a theme, discussion questions, a matrix to define strengths and weaknesses, as well as a task to formulate goals to improve existing routines regarding diet and physical activity according to local needs and opportunities. The specific content of ‘Focus Health’ has been described previously (Elinder et al., 2010).

2.2.3. Health course for residents

The participants in each residence were offered a health course, called ‘driver’s license for health’, with the aim of improving their health literacy and healthy behaviours in a pleasant way. The course took place in common rooms in each residence, also using the kitchen and the neighbourhood. It was conducted according to a manual and was led by a course leader from a national educational association for adults. The course included ten sessions, where the participants had opportunities to learn about health issues and to try out healthy foods and physical activities. A participatory approach was encouraged. The specific content of the material has been described elsewhere (Elinder et al., 2010).

2.2.4. Intervention fidelity

Intervention fidelity, defined as the extent to which a programme adheres to its programme theory (Fraser, 2009), is crucial to understanding the causal mechanisms (Mercer, DeVinney, Fine, Green, & Dougherty, 2007). In this study fidelity was measured as the dose delivered. Health ambassadors’ level of activity was measured by attendance at network meetings: five points for each meeting, which gave a possible score of 30 points. Level of activity in the study circle for caregivers and in the health course for residents was measured by the number of sessions held; three points for each session gave a possible score of 30 points for each component. To study a possible dose-effect relationship, the intervention residences were divided into high fidelity or low fidelity, by splitting by the median value of the total fidelity score.

2.3. Outcome variables

Outcomes were collected by researchers at baseline, between December 2009 and November 2010, and at the end of the intervention after 12–16 months from baseline date in each residence. As described in the trial protocol, the primary outcome was physical activity (Elinder et al., 2010). Secondary outcome measures were BMI, waist circumference, dietary quality, satisfaction with life, and work routines.

2.3.1. Physical activity

Physical activity was assessed as steps/day, by use of a pedometer. The pedometer used was Keep Walking LS2000, which is 50 mm × 35 mm × 10 mm and measures steps using a spring-suspended horizontal lever that moves up and down in response to the hip's vertical accelerations. The Keep Walking LS2000 pedometer shows good compliance with accelerometers (Tudor-Locke, Ainsworth, Thompson, & Matthews, 2002) and has been recommended for research purposes (Schneider, Crouter, & Bassett, 2004).

Researchers introduced the pedometer to the participants, together with caregivers, and instructed them how to wear it correctly. The participants were asked to wear the pedometer in the waistband in line with the right knee for seven consecutive days and to write down each evening the number of steps they took that day. Caregivers were instructed to support the participants and to offer assistance when needed. Participants using wheel chair ($n = 2$) were excluded, but all ambulatory individuals were encouraged to participate, regardless of minor movement disabilities.

The outcome variable was calculated as an average of steps per day. Only step counts from participants who used their pedometer for three days or more were included, because previous research shows that three days' measurement with pedometers is needed to predict average steps/week among ambulatory adults with ID (Temple & Stanish, 2009). Step counts below 500 steps/day were regarded as invalid and excluded, since we believed that lower step count might be due to incorrect use.

2.3.2. BMI and waist circumference

Data on height, weight, and waist circumference were collected by the research team during visits in the community residences. To measure height a Stadiometer, SECA 214, was used; to measure weight a scale, Robusta 813, was used; and to measure waist circumference a measuring tape was used. The scale was calibrated before the first measurement, as well as between the first and the second measurement. During measurements the participants kept their clothes on, but were asked to take off shoes and heavy clothing and to empty their pockets. Waist circumference (cm) was measured at the thinnest point, between the lowest rib and the iliac crest, at the end of gentle expiration.

Waist circumference is presented as an average for the whole group, but baseline values are also presented for men and women separately, because the threshold for an unhealthy waist circumference differs between men and women. Height (m) and weight (kg) were used to calculate body mass index (BMI) (kg/m^2) for each participant. Cut-off points for BMI groups were underweight BMI $<$18.5 kg/m^2, normal weight BMI 18.5–24.99 kg/m^2, overweight BMI 25–29.99 kg/m^2, and obesity $\geq$30 kg/m^2(World Health Organization, 1997).

2.3.3. Dietary quality

Dietary quality was assessed by use of a camera, Canon PowerShot A480. This method has shown to be a feasible, reliable, and valid method for assessing dietary quality in people with mild or moderate ID who have daily staff support (Elinder, Brunosson, Bergstrom, Hagstromer, & Patterson, 2011). The research team introduced the camera to the participants, together with caregivers, and instructed them how to use it. The participants were asked to take pictures of everything they were eating and drinking during three days, of which two should be workdays and one should be a weekend day. Caregivers were instructed to remind the participants and offer assistance when needed. Food photographs were automatically labelled with date and time, and different meals were identified according to the time of day they and the amount of food (Elinder et al., 2011). The photographs were coded and analysed according to four aspects, which are also outcome variables: food diversity, vegetable consumption, lunches complying with the plate model (see below), and dinners complying with the plate model. Food diversity referred to the average number of food groups eaten per day, where one point was assigned when a participant consumed any amount of one of nine core food groups (Elinder et al., 2011). Vegetable consumption referred to the average number of occasions per day when vegetables were consumed, regardless of amount. Not all of the participants provided photos from three days, and it was decided to include data from a participant if there were photos from at least one valid day. A day was deemed valid if there were photos from at least two main meals.

Lunches and dinners complying with the plate model referred to whether the first photographed workday lunch and dinner for each participant complied with the plate model (Camelon et al., 1998) or not. This model includes three different food groups in given proportions: (1) carbohydrate-rich foods (37.5% of plate surface); (2) vegetables and fruits (37.5% of plate surface); and (3) protein-rich foods (25% of plate surface). This was evaluated by visually comparing the photographs to the plate model, which was coded as a dichotomous variable (yes/no). All photographs were coded and discussed by two raters in order to achieve consensus.

2.3.4. Satisfaction with life

The reason for studying satisfaction with life was mainly to monitor possible adverse effects of the intervention (Elinder et al., 2010). This outcome was assessed by use of a scale with four factors: (1) satisfaction with housing environment; (2) satisfaction with life; (3) satisfaction with meals; and (4) satisfaction with recreational activities. Items could be answered by 'good' (happy face = 2), 'in between' (neutral face = 1) or 'bad' (sad face = 0). The items were read out loud to the participants by a researcher in a secluded room in the residences. The respondents answered by saying the answer or by pointing at a happy, sad, or neutral face. The scale was tested for its psychometric aspects among the participants of the present intervention, and it was concluded that the scale had fairly good psychometric properties (Bergstrom, Hochwalder, Kottorp, & Elinder, 2012). The outcome variable was a total mean score, a sum between 0 and 2, where 2 corresponded to 'good'.

2.3.5. Work routines

Data on work routines for meals, physical activity, and health were collected by a questionnaire to managers and/or caregivers, which was developed for this purpose (Elinder et al., 2010). The questionnaire included 26 items within three domains: (1) general health-promoting work; (2) food and meals; and (3) physical activity. Each item had four response options, corresponding to fully in place (3 points), partially in place (2 points), under development (1 point), and not in place (0 points). Outcomes were reported as the mean percentage of the total score as well as of each domain.

Face validity of the questionnaire was confirmed by testing with caregivers and their superiors. Test-retest reliability was assessed in two separate assessments, three weeks apart, in 30 residences not included in the trial. Analysis was done by intra-class correlations (ICC) using a two-way mixed model with absolute agreement. ICC was 0.80 for the total score, 0.84 for general health promotion work, 0.78 for food and meals, and 0.83 for physical activity. Reliability was considered excellent because an ICC coefficient higher than 0.75 has been suggested to indicate excellent agreement (McDowell, 2006).

2.4. Statistical analysis

The sample size calculation showed that 32 community residences were needed to detect a significant change in physical activity of 25% between the intervention and control group (Elinder et al., 2010). The calculation was two-sided, and power was set to 80%, the significance level to 5%, and cluster size to five individuals. Differences in baseline characteristics between the intervention and control group, as well as between the residences that dropped out and those that were included, were tested by an independent *t*-test for continuous data and by a χ^2 test for categorical data. ICC was calculated between residence and the primary outcome variable steps/day at baseline, comparing the variance within clusters with the variance between clusters. To test possible intervention effects on residence level outcomes (work routines) linear regression/ANCOVA was used. To test possible effects on individual level outcomes (physical activity, dietary quality, BMI, waist circumference and satisfaction with life) linear regression/ANCOVA was used for continuous outcomes and modified Poisson regression was used for dichotomous outcomes (Zou, 2004). All analyses were adjusted for baseline values. In the initial analyses the variables sex, age, movement disability, and type of residence were used as covariates. The variable 'type of residence' was treated as an individual level variable since it can be seen as a proxy for the individual's level of disability and support needs. Only 'type of residence' was a significant covariate for several outcomes, and therefore chosen to be included in the analyses. The final analyses on individual outcomes were conducted as multi-level analyses when possible with regard to sample size, adjusted for baseline values and type of residence. We also controlled for the possible interaction between the assignment group (intervention/control) and the variable 'type of residence'. Because there was an interaction, we performed a stratified analysis on this variable.

Possible intervention effects were tested according to the principle of intention to treat, both with and without imputation of missing post intervention data, according to the last value carried forward procedure (Elliott & Hawthorne, 2005), but are presented as complete data without imputation. In the analysis with imputation of data individuals with one or more days of step counts were included. Effects were also analysed in relation to fidelity in the intervention group only, by including a dichotomous dose-variable in the regression equation. Effect size was calculated for the primary outcome variable according to Cohen's *d* (Cohen, 1977).

A p-value <0.05 was considered significant. Analyses were performed using the statistical programme package IBM SPSS Statistics (version 20 for Windows, 2011, SPSS Inc., Chicago, IL).

3. Results

Thirty community residences entered the study, 14 in the intervention group and 16 in the control group. In total, 130 participants entered and 129 completed the study (Fig. 1). The three residences that dropped out before the intervention started and the nine individuals living in those residences did not differ from the remaining residences or participants on any baseline characteristics or outcome variables, except for dinners, which to a lesser extent complied with the plate model among the dropouts ($P = 0.023$).

The participants did not always want to participate in the measurements, resulting in missing values. For some participants with extensive movement disabilities it was difficult to measure physical activity using the pedometer or they

Table 1
Baseline characteristics of community residences and participants randomised to intervention or control group. Values are numbers (percentages) unless stated otherwise.

Variable	Intervention	Control
Community residences	$n = 14$	$n = 16$
Group home	10 (71.4)	11 (68.8)
Supported living	4 (28.6)	5 (31.2)
Managed by municipality	13 (92.9)	12 (75.0)
Managed by company/organisation	1 (7.1)	4 (25.0)
Mean (SD) number of staff	6.8 (2.2)	7.8 (3.7)
Mean (SD) number of residents	6.8 (2.6)	7.3 (3.5)
Participants	$n = 64$	$n = 66$
Women	37 (57.8)	37 (56.1)
Mean (SD) age (years)	36.2 (10.1)	39.4 (11.3)[†]
Born in Sweden	55 (85.9)	53 (81.5)[†]
Living in group home	53 (82.8)	46 (69.7)
Living in supported living	11 (17.2)	20 (30.3)
Occupation ≥3 days/week	61 (95.3)	58 (89.3)[†]
Movement disability	8 (12.5)	11 (16.9)[†]
Sensory loss	33 (51.6)	29 (44.6)[†]
Allergy/asthma	15 (23.4)	12 (18.5)[†]
Diabetes	6 (9.4)	1 (1.5)[*,†]
Epilepsy	15 (23.4)	8(12.3)[†]

[*] Significant difference $p < 0.05$.
[†] $n = 65$.

had difficulty placing themselves on the scale, which also resulted in missing data. The number of participants in each analysis is given in the tables.

3.1. Baseline characteristics

Baseline characteristics are shown in Table 1. Of the residences, 21 were group homes and nine were homes with supported living. Twenty-five residences were managed by the municipality and five by a private company or a non-profit organisation. The age of the participants ranged from 20 to 66 years. There were no significant differences between the intervention and the control groups on any characteristics except for prevalence of diabetes, which was higher in the intervention group ($P = 0.049$).

Outcome variables at baseline are shown in Table 2. Of the participants 2.4% were underweight, 27.8% were normal weight, 27.0% were overweight, and 42.9% were obese. BMI mean value (SD) was 27.4 kg/m^2 (5.9) among men and 30.7 kg/m^2 (7.6) among women ($P = 0.010$). There were no significant differences in outcome variables between the intervention and control group except for work routines, where the control group scored higher on the total score ($P = 0.027$) as well as on the domain of general health promoting work ($P = 0.044$). The participants with pedometry data at baseline only did not

Table 2
Outcome variables of community residences and participants randomised to intervention or control group at baseline. Values are mean (SD) unless stated otherwise.

Variable	Number intervention/control	Intervention	Control
Community residences			
Work routines			
General health (% of full score)	14/16	55.5 (16.7)	68.8 (17.6)[*]
Food and meals (% of full score)	14/16	52.1 (9.5)	56.7 (10.3)
Physical activity (% of full score)	14/16	73.8 (11.8)	82.6 (13.1)
Total score (% of full score)	14/16	60.1 (10.4)	69.3 (11.2)[*]
Participants			
Physical activity (steps/day)	46/53	8042 (5524)	6296 (4167)
BMI (kg/m^2)	63/63	30.0 (7.6)	28.5 (6.6)
Waist circumference (cm)	61/63	94.5 (16.5)	92.8 (13.7)
Men	27/28	97.2 (19.0)	92.4 (10.3)
Women	34/35	92.4 (14.1)	93.2 (16.1)
Dietary quality			
Food diversity (groups/day)	45/46	5.4 (1.0)	5.8 (1.2)
Vegetable consumption (occasions/day)	45/56	1.4 (0.6)	1.7 (0.7)
No (%) lunches complying with the plate model	44/46	23 (52.3)	23 (50.0)
No (%) dinners complying with the plate model	43/51	27 (62.8)	28 (54.9)
Satisfaction with life (point on 0–2 scale)	61/61	1.8 (0.3)	1.7 (0.3)

[*] Significant difference, $p < 0.05$.

Table 3
Effects of the intervention on work routines, physical activity, BMI, waist circumference, dietary quality, and satisfaction with life, results of linear regression. All analyses are adjusted for baseline values.

	Number intervention/control	*b* (95% C.I.)	*P* value
Community residences			
Work routines			
General health (% of full score)	14/15	9.8 (2.5 to 17.1)	0.010
Food and meals (% of full score)	14/15	4.6 (−5.0 to 14.2)	0.333
Physical activity (% of full score)	14/15	7.0 (0.2 to 13.8)	0.043
Total score (% of full score)	14/15	7.1 (1.5 to 12.8)	0.016
Participants			
Physical activity (steps/day)[*,†]	32/37	1608 (42 to 3173)	0.045
Within group homes[*]	24/23	750 (−1150 to 2650)	0.411
Within supported living[*]	8/14	3496 (346 to 6646)	0.031
BMI (kg/m^2)[†]	53/55	−0.3 (−1.1 to 0.5)	0.430
Waist circumference (cm)[*,†]	50/53	−1.7 (−4.0 to 0.6)	0.130
Dietary quality			
Food diversity (groups/day)[*,†]	31/35	0.2 (−0.4 to 0.8)	0.589
Vegetables (occasions/day)[*,†]	31/35	0.2 (−0.1 to 0.5)	0.239
Lunches complying with the plate model[†]	34/29	−0.1 (−0.6 to 0.4)	0.794
Dinners complying with the plate model[†]	30/36	0.1 (−0.2 to 0.5)	0.539
Satisfaction with life (points on 0–2 scale)[†]	51/53	0.0 (−0.1 to 0.1)	0.496

[*] Adjusted for clustering.
[†] Adjusted for type of residence.

differ significantly in steps/day from the participants with measurements before and after the intervention. The intra-class correlation coefficient (ICC) for the primary outcome variable steps/day at baseline was 0.149, indicating to what extent the outcomes were clustered within residences.

3.2. Intervention fidelity

The median value (min–max) of the total fidelity score was 65 (19–85) out of a possible maximum of 90, with seven residences in the high-fidelity group and seven residences in the low-fidelity group. Median value (min–max) for each component was 15 (0–25) for health ambassadors, 18 (0–30) for the study-circle for caregivers, and 30 (0–30) for the health course for the residents.

3.3. Effects of the intervention

A significant effect was found on physical activity, assessed as steps/day, controlling for baseline values, clustering, and type of residence (Table 3). The participants in the intervention group increased their physical activity by 1608 steps/day, which was significantly more than the control group did ($P = 0.045$). Intention to treat analysis using the last value carried forward imputation procedure showed an increase of 1203 steps/day compared to the control group ($P = 0.039$). 'Type of residence' was found to moderate the effect of the intervention. Therefore a stratified analysis was performed showing that the increase was statistically significant only in homes with supported living ($P = 0.031$). The effect size for the primary outcome variable was $d = 0.29$.

A significant intervention effect was found on total work routines ($P = 0.016$) as well as for the domains of general health promotion work ($P = 0.010$) and physical activity ($P = 0.043$). No significant effect of the intervention was found on BMI, dietary quality, or satisfaction with life, although outcomes for waist circumference were in the desired direction. The high-fidelity group improved their results more than the low-fidelity group both on work routines and physical activity, but this difference was not significant (not shown).

4. Discussion

To our knowledge, this is the first study of a universal health intervention directed at improving diet and physical activity for adults with ID, targeting both caregivers and residents. Positive intervention effects were seen for physical activity as well as on general work routines and routines for physical activity, indicating that this approach might be an effective way of improving health behaviours in community residences, although the effect size was small. Stratified analysis suggested that the effect on physical activity was stronger in homes with supported living, where residents in general are more self-supporting than in group homes. This finding is not completely unexpected, because it seems reasonable to assume that individuals with higher intellectual and cognitive capacity are more easily influenced by the intervention. The high-fidelity group improved their results more than the low-fidelity group, both on physical activity and work routines, which suggests a dose-effect, although this difference was not statistically significant. This is an encouraging finding because it suggests that higher fidelity could lead to even better results in future studies.

No significant effects were seen on BMI, waist circumference, dietary quality, or satisfaction with life, although the effect on waist circumference was in the desired direction. We did not expect to see significant effects on BMI, since the study was not powered for this purpose (Elinder et al., 2010). However, in a future study with a larger sample size and higher fidelity, this effect could become statistically and clinically significant. The lack of effect on dietary quality was paralleled by a lack of significant effect on work routines concerning foods and meals. In our experience, the issue of food and meals is more sensitive than physical activity. Therefore the lack of effect could be due to ineffective work routines, insufficient implementation and/or that the method of assessment was not sensitive enough. A combination of these three factors is probably the best explanation, having room for improvement in future studies. By monitoring actual changes in work routines in a more comprehensive way it would be possible to get more detailed information about what works.

The scale used to assess satisfaction with life has fairly good psychometric properties (Bergstrom et al., 2012), but because a majority of answers were at the positive end of the scale already at baseline, there was not much room for improvement. On the other hand, the main reason to use this scale was to monitor potential adverse effects in this vulnerable group. No deterioration was found, which was taken as an indication that the intervention was not perceived as inappropriate or negative by the participants.

The results of the intervention are encouraging and in line with previous health promotion and weight loss interventions, which have shown that interventions incorporating physical activity, nutrition, and health behaviour education can have some positive impacts on health of the target group (Heller et al., 2011; Jinks et al., 2011). The present intervention included three components, of which one involved mainly the residents and two involved the caregivers. The importance of caregiver involvement has been highlighted previously. In an individual weight loss intervention involving family or paid carers, significant decreases in body weight, waist circumference, and sedentary behaviours were achieved (Melville et al., 2011), and in a review of weight loss interventions it was concluded that there is evidence to support interventions that take account of context and carer involvement (Hamilton et al., 2007).

A strength of the intervention is that it targeted both residents and caregivers, which is important to successfully sustain changes after the end of the intervention (Hamilton et al., 2007). Another strength is that the programme was adapted to fit the existing values and practices in the community residences, which was achieved by including managers and representatives for the target group in the development of the intervention (Elinder et al., 2010). High compatibility and adaptability should make things easier for providers and organisations when implementing a programme (Durlak & DuPre, 2008) and ensuring sustainability (Scheirer & Dearing, 2011). As proposed by Hawe, in complex interventions like the present one, the function and the process should be standardised rather than the exact content of the intervention components, thereby allowing a high degree of contextual adaptation (Hawe et al., 2004).

Leading experts in implementation research have called for a clear description of complex behaviour change interventions because inconsistent use of terminology constrains scientific replication and limits the use of successful interventions (Michie, Fixsen, Grimshaw, & Eccles, 2009). In this study we have described the intervention and its components, and a study protocol has been published ahead of the study. Furthermore, we have assessed intervention fidelity, defined as the extent to which a programme adheres to its programme theory (Fraser, 2009), which is crucial to understand causality (Mercer et al., 2007). In this study fidelity was assessed regarding the dose delivered of all three intervention components. The reason for the incomplete delivery of the staff components might be that this multi-component intervention was perceived as time-consuming by caregivers, especially in combination with the measurements, where the caregivers had to assist the participants with photography and pedometry. Future studies should try to minimise the burden on caregivers with regard to data collection.

Collecting data in this target group offered several challenges regarding the individual's interest and ability to participate in each specific measurement as well as the motivation among the caregivers to give support, which threatened the power of the study. Seasonal differences might have affected the level of physical activity, but since measurements were conducted throughout the year, both in the intervention and control group, we do not think that it affected the outcomes. Work routines were assessed by self-assessment, which can be considered as a weakness as well. However a rigorous design, including multi-level analysis, supports internal validity of the study.

The results of this study are encouraging, because they imply that a three component intervention, targeting the residents as well as the caregivers, might be effective in promoting healthy behaviours among adults with ID. On the basis of this first study, refinements will be made with regard to implementation strategies, in order to increase fidelity. Another aspect to investigate further is how this programme can be modified to better fit needs in different subgroups, such as group homes and supported living. It might be hypothesised that there will be differences in effect between types of residences that offer more or less support, because of organisational and individual factors. Therefore, in future studies the sample should be stratified from the beginning according to the type of residence. Another aspect to consider is the time of assessment of effects. It cannot be excluded that it takes longer to achieve effects in group homes compared to homes with supported living.

These results were obtained in homes located all around Stockholm County, and therefore it can be assumed that the results are generalisable to similar contexts, regarding the participants as well as type of residences. To attain more information about outcomes of implementation, like acceptability and feasibility (Proctor et al., 2011), a qualitative interview study has been conducted and the results will be reported in a separate study.

5. Conclusion

A universal intervention to improve diet and physical activity, targeting both caregivers and residents in community residences for people with ID, can be effective in improving physical activity and work routines. The intervention consisted of three components which were tailored to local needs by the participants. It is possible to assume that even greater effectiveness could be achieved by improved implementation strategies leading to a higher fidelity for the staff components. Considering the large and unnecessary disease burden carried by this vulnerable group, we hope that further work will lead to better health programmes and health outcomes for this target group.

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